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1 [Set-associative cache simulation using generalized binomial trees](#)



Rabin A. Sugumar, Santosh G. Abraham

February 1995 **ACM Transactions on Computer Systems (TOCS)**, Volume 13 Issue 1

Publisher: ACM Press

Full text available:  [pdf\(1.51 MB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#), [review](#)

Set-associative caches are widely used in CPU memory hierarchies, I/O subsystems, and file systems to reduce average access times. This article proposes an efficient simulation technique for simulating a group of set-associative caches in a single pass through the address trace, where all caches have the same line size but varying associativities and varying number of sets. The article also introduces a generalization of the ordinary binomial tree and presents a representation of caches in ...

Keywords: all-associativity simulation, binomial tree, cache modeling, inclusion properties, set-associative caches, single-pass simulation, trace-driven simulation

2 [Processor microarchitecture I: Partitioned first-level cache design for clustered microarchitectures](#)



Paul Racunas, Yale N. Patt

June 2003 **Proceedings of the 17th annual international conference on Supercomputing**

Publisher: ACM Press

Full text available:  [pdf\(191.74 KB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

The high clock frequencies of modern superscalar processors make the wire delay incurred in moving data across the processor chip a significant concern. As frequencies continue to increase, it will become more difficult for a centralized first level data cache to supply the timely data bandwidth required by superscalar processors. This paper presents a complete solution for the partitioning of the first level of the memory hierarchy. The first level data cache is split into several independent pa ...

Keywords: clustered microarchitecture, partitioned cache

3 [Session 8C: The set-associative cache performance of search trees](#)

James D. Fix

January 2003 **Proceedings of the fourteenth annual ACM-SIAM symposium on Discrete algorithms**

Publisher: Society for Industrial and Applied Mathematics

Full text available:  [pdf\(787.50 KB\)](#)

Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

We consider the costs of access to data stored in search trees assuming that those memory accesses are managed with a cache. Our cache memory model is two-level, has a small degree of set-associativity, and uses LRU replacement, and we consider the number of cache misses that a set of accesses incurs. For standard tree access--searches and traversals---changing the degree of set-associativity has no effect on performance. To explain this, we develop general stochastic access models, an adaptation ...

4 Cache memory performance in a unix enviroment



Cedell Alexander, William Keshlear, Furrokh Cooper, Faye Briggs

June 1986 **ACM SIGARCH Computer Architecture News**, Volume 14 Issue 3

Publisher: ACM Press

Full text available: [pdf\(2.10 MB\)](#) Additional Information: [full citation](#), [citations](#), [index terms](#)

5 On the inclusion properties for multi-level cache hierarchies



J.-L. Baer, W.-H. Wang

May 1988 **ACM SIGARCH Computer Architecture News , Proceedings of the 15th Annual International Symposium on Computer architecture ISCA '88**, Volume 16 Issue 2

Publisher: IEEE Computer Society Press, ACM Press

Full text available: [pdf\(886.24 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

The inclusion property is essential in reducing the cache coherence complexity for multiprocessors with multilevel cache hierarchies. We give some necessary and sufficient conditions for imposing the inclusion property for fully- and set-associative caches which allow different block sizes at different levels of the hierarchy. Three multiprocessor structures with a two-level cache hierarchy (single cache extension, multiport second-level cache, bus-based) are examined. The feasibility of im ...

6 Towards a theory of cache-efficient algorithms



Sandeep Sen, Siddhartha Chatterjee, Neeraj Dumir

November 2002 **Journal of the ACM (JACM)**, Volume 49 Issue 6

Publisher: ACM Press

Full text available: [pdf\(273.41 KB\)](#) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

We present a model that enables us to analyze the running time of an algorithm on a computer with a memory hierarchy with limited associativity, in terms of various cache parameters. Our cache model, an extension of Aggarwal and Vitter's I/O model, enables us to establish useful relationships between the cache complexity and the I/O complexity of computations. As a corollary, we obtain cache-efficient algorithms in the single-level cache model for fundamental problems like sorting, FFT, and an i ...

Keywords: Hierarchical memory, I/O complexity, lower bound

7 The V-Way Cache: Demand Based Associativity via Global Replacement



Moinuddin K. Qureshi, David Thompson, Yale N. Patt

May 2005 **ACM SIGARCH Computer Architecture News , Proceedings of the 32nd Annual International Symposium on Computer Architecture ISCA '05**, Volume 33 Issue 2

Publisher: IEEE Computer Society, ACM Press

Full text available: [pdf\(231.93 KB\)](#) Additional Information: [full citation](#), [abstract](#), [index terms](#)

As processor speeds increase and memory latency becomes more critical, intelligent design and management of secondary caches becomes increasingly important. The efficiency of current set-associative caches is reduced because programs exhibit a non-uniform distribution of memory accesses across different cache sets. We propose a technique to vary the associativity of a cache on a per-set basis in response to the demands of the program. By increasing the number of tag-store entries relative to the ...

8 On the inclusion properties for multi-level cache hierarchies



Jean-Loup Baer, Wen-Hann Wang

August 1998 **25 years of the international symposia on Computer architecture (selected papers)**

Publisher: ACM Press

Full text available: pdf(876.77 KB) Additional Information: [full citation](#), [references](#), [citations](#), [index terms](#)

9 Cache optimization for embedded processor cores: An analytical approach



Arijit Ghosh, Tony Givargis

October 2004 **ACM Transactions on Design Automation of Electronic Systems (TODAES)**, Volume 9 Issue 4

Publisher: ACM Press

Full text available: pdf(236.72 KB) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Embedded microprocessor cores are increasingly being used in embedded and mobile devices. The software running on these embedded microprocessor cores is often a priori known; thus, there is an opportunity for customizing the cache subsystem for improved performance. In this work, we propose an efficient algorithm to directly compute cache parameters satisfying desired performance criteria. Our approach avoids simulation and exhaustive exploration, and, instead, relies on an exact algorithmic ...

Keywords: Cache optimization, core-based design, design space exploration, system-on-a-chip

10 Decoupled sectored caches: conciliating low tag implementation cost



A. Seznec

April 1994 **ACM SIGARCH Computer Architecture News , Proceedings of the 21ST annual international symposium on Computer architecture ISCA '94**, Volume 22 Issue 2

Publisher: IEEE Computer Society Press, ACM Press

Full text available: pdf(1.06 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Sectored caches have been used for many years in order to reconcile low tag array size and small or medium block size. In a sectored cache, a single address tag is associated with a sector consisting on several cache lines, while validity, dirty and coherency tags are associated with each of the inner cache lines. Maintaining a low tag array size is a major issue in many cache designs (e.g. L2 caches). Using a sectored cache is a design trade-off between a low size of the tag array which is possi ...

11 Tradeoffs in two-level on-chip caching



N. P. Jouppi, S. J. E. Wilton

April 1994 **ACM SIGARCH Computer Architecture News , Proceedings of the 21ST annual international symposium on Computer architecture ISCA '94**, Volume 22 Issue 2

Publisher: IEEE Computer Society Press, ACM Press

Full text available: pdf(1.16 MB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

The performance of two-level on-chip caching is investigated for a range of technology and architecture assumptions. The area and access time of each level of cache is modeled in detail. The results indicate that for most workloads, two-level cache configurations (with a set-associative second level) perform marginally better than single-level cache configurations that require the same chip area once the first-level cache sizes are 64KB or larger. Two-level configurations become even more import ...

12 The pool of subsectors cache design



Jeffrey B. Rothman, Alan Jay Smith

May 1999 **Proceedings of the 13th international conference on Supercomputing**

Publisher: ACM Press

Full text available: pdf(1.69 MB) Additional Information: [full citation](#), [references](#), [citations](#), [index terms](#)

13 Cache performance of operating system and multiprogramming workloads



Anant Agarwal, John Hennessy, Mark Horowitz

November 1988 **ACM Transactions on Computer Systems (TOCS)**, Volume 6 Issue 4

Publisher: ACM Press

Full text available: pdf(3.16 MB)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#), [review](#)

Large caches are necessary in current high-performance computer systems to provide the required high memory bandwidth. Because a small decrease in cache performance can result in significant system performance degradation, accurately characterizing the performance of large caches is important. Although measurements on actual systems have shown that operating systems and multiprogramming can affect cache performance, previous studies have not focused on these effects. We have developed a pro ...

14 Trace-driven simulations for a two-level cache design in open bus systems



Håkon O. Bugge, Ernst H. Kristiansen, Bjørn O. Bakka

May 1990 **ACM SIGARCH Computer Architecture News , Proceedings of the 17th annual international symposium on Computer Architecture ISCA '90**, Volume 18 Issue 3a

Publisher: ACM Press

Full text available: pdf(1.20 MB)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

Two-level cache hierarchies will be a design issue in future high-performance CPUs. In this paper we evaluate various metrics for data cache* designs. We discuss both one- and two-level cache hierarchies. Our target is a new 100+ mips CPU, but the methods are applicable to any cache design. The basis of our work is a new trace-driven, multiprocess cache simulator. The simulator incorporates a simple priority-based scheduler which controls the execution ...

15 A case for two-way skewed-associative caches



André Seznec

May 1993 **ACM SIGARCH Computer Architecture News , Proceedings of the 20th annual international symposium on Computer architecture ISCA '93**, Volume 21 Issue 2

Publisher: ACM Press

Full text available: pdf(975.20 KB)

Additional Information: [full citation](#), [references](#), [citations](#), [index terms](#)

16 Inexpensive implementations of set-associativity



R. E. Kessler, R. Jooss, A. Lebeck, M. D. Hill

April 1989 **ACM SIGARCH Computer Architecture News , Proceedings of the 16th annual international symposium on Computer architecture ISCA '89**, Volume 17 Issue 3

Publisher: ACM Press

Full text available: pdf(1.16 MB)

Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

The traditional approach to implementing wide set-associativity is expensive, requiring a wide tag memory (directory) and many comparators. Here we examine alternative implementations of associativity that use hardware similar to that used to implement a direct-mapped cache. One approach scans tags serially from most-recently used to least-recently used. Another uses a partial compare of a few bits from each tag to reduce the number of tags that must be examined serially. The drawback of bo ...

17 Use-Based Register Caching with Decoupled Indexing



J. Adam Butts, Gurindar S. Sohi

March 2004 **ACM SIGARCH Computer Architecture News , Proceedings of the 31st annual international symposium on Computer architecture ISCA '04**, Volume 32 Issue 2

Publisher: IEEE Computer Society, ACM Press

Wide, deep pipelines need many physical registers to hold the results of in-flight instructions. Simultaneously, high clock frequencies prohibit using large register files and bypass networks without a significant performance penalty. Previously proposed techniques using register caching to reduce this penalty suffer from several problems including poor insertion and replacement decisions and the need for a fully-associative cache for good performance. We present novel mechanisms for managing and indexing ...

18 Cache Optimization For Embedded Processor Cores: An Analytical Approach

Arijit Ghosh, Tony Givargis

November 2003 **Proceedings of the 2003 IEEE/ACM international conference on Computer-aided design**

Publisher: IEEE Computer Society

Full text available:  pdf(141.16 KB) Additional Information: [full citation](#), [abstract](#), [index terms](#)

Embedded microprocessor cores are increasingly being used in embedded and mobile devices. The software running on these embedded microprocessor cores is often apriori known, thus, there is an opportunity for customizing the cache subsystem for improved performance. In this work, we propose an efficient algorithm to directly compute cache parameters satisfying desired performance criteria. Our approach avoids simulation and exhaustive exploration, and, instead, relies on an exact algorithmic approach. We ...

Keywords: Cache Optimization, Core-Based Design, Design Space Exploration, System-on-a-Chip


19 System-level power optimization: techniques and tools



Luca Benini, Giovanni de Micheli

April 2000 **ACM Transactions on Design Automation of Electronic Systems (TODAES)**, Volume 5 Issue 2

Publisher: ACM Press

Full text available:  pdf(385.22 KB) Additional Information: [full citation](#), [abstract](#), [references](#), [citations](#), [index terms](#)

This tutorial surveys design methods for energy-efficient system-level design. We consider electronic systems consisting of a hardware platform and software layers. We consider the three major constituents of hardware that consume energy, namely computation, communication, and storage units, and we review methods of reducing their energy consumption. We also study models for analyzing the energy cost of software, and methods for energy-efficient software design and compilation. This survey ...

20 Cache: Enhancing data cache reliability by the addition of a small fully-associative replication cache



Wei Zhang

June 2004 **Proceedings of the 18th annual international conference on Supercomputing**

Publisher: ACM Press

Full text available:  pdf(265.07 KB) Additional Information: [full citation](#), [abstract](#), [references](#), [index terms](#)

Soft error conscious cache design is a necessity for reliable computing. ECC or parity-based integrity checking technique in use today either compromises performance for reliability or vice versa, and the N modular redundancy (NMR) scheme is too costly for microprocessors and applications with stringent cost constraint. This paper proposes a novel and cost-effective solution to enhance data reliability with minimum impact on performance. The idea is to add a small fully-associative cache to stor ...

Keywords: in-cache replication, soft error, write-back cache

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Batson, B.; Vijaykumar, T.N.;
[Parallel Architectures and Compilation Techniques, 2001. Proceedings. 2001 International Conference on](#)
8-12 Sept. 2001 Page(s):49 - 60
Digital Object Identifier 10.1109/PACT.2001.953287
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- ☐ **2. Design of an adjustable-way set-associative cache**
Hsin-Chuan Chen; Jen-Shiun Chiang;
[Communications, Computers and signal Processing, 2001. PACRIM. 2001 IEEE Pacific Rim Conference on](#)
Volume 1, 26-28 Aug. 2001 Page(s):315 - 318 vol.1
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[AbstractPlus](#) | Full Text: [PDF\(360 KB\)](#) IEEE CNF
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- ☐ **3. Pseudo 3-way set-associative cache: a way of reducing miss ratio with fast access time**
Yongjoon Lee; Byung-Kwon Chung;
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Volume 1, 9-12 May 1999 Page(s):391 - 396 vol.1
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- ☐ **4. Hierarchical multiple associative mapping in cache memories**
Zarandi, H.R.; Miremadi, S.G.;
[Engineering of Computer-Based Systems, 2005. ECBS '05. 12th IEEE International Conference and Workshops on the](#)
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Chuanjun Zhang; Vahid, F.; Jun Yang; Najjar, W.;
[Low Power Electronics and Design, 2004. ISLPED '04. Proceedings of the 2004 International Symposium on](#)
9-11 Aug. 2004 Page(s):126 - 131
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- ☐ **6. Two fast and high-associativity cache schemes**
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Volume 17, Issue 5, Sept.-Oct. 1997 Page(s):40 - 49
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- ☐ **7. A fully associative software-managed cache design**
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Yuguang Wu; Muntz, R.;
Parallel and Distributed Systems, IEEE Transactions on
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Rui Min; Yiming Hu;
Computers, IEEE Transactions on
Volume 50, Issue 11, Nov. 2001 Page(s):1191 - 1201
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Jia-Jhe Li; Yuan-Shin Hwang;
Low Power Electronics and Design, 2005. ISLPED '05. Proceedings of the 2005 International Symposium on
8-10 Aug. 2005 Page(s):345 - 350
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Aly, R.E.; Nallamilli, B.R.; Bayoumi, M.A.;
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Chuanjun Zhang; Vahid, F.; Jun Yang; Najjar, W.;
Low Power Electronics and Design, 2004. ISLPED '04. Proceedings of the 2004 International Symposium on
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14. Power-aware deterministic block allocation for low-power way-selective cache structure

- ☐ Jung-Wook Park; Gi-Ho Park; Sung-Bae Park; Shin-Dug Kim;
[Computer Design: VLSI in Computers and Processors, 2004. ICCD 2004. Proceedings. IEEE International Conference on](#)
11-13 Oct. 2004 Page(s):42 - 47
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Nadathur, S.; Tyagi, A.;
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- ☐ **16. Partial tag comparison: a new technology for power-efficient set-associative cache designs**
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- ☐ **17. Reducing set-associative cache energy via way-prediction and selective direct-mapping**
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- ☐ **18. UltraSPARC-III: a 3rd generation 64 b SPARC microprocessor**
Lauterbach, G.; Greenley, D.; Ahmed, S.; Boffey, M.; Chamdani, J.; Si-En Chang; Chen, D.; Yu Fang; Holdbrook, K.; Hsieh, M.; Keish, B.; Melanson, R.; Narasimhaiah, C.; Petolino, J.; Tung Pham; Le Quach; Kit Tam; Duong Tong; Liuxi Yang; Kui Yau;
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7-9 Feb. 2000 Page(s):410 - 411
Digital Object Identifier 10.1109/ISSCC.2000.839837
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Jun Xu; Singhal, M.; Degroat, J.;
[INFOCOM 2000. Nineteenth Annual Joint Conference of the IEEE Computer and Communications Societies. Proceedings. IEEE](#)
Volume 3, 26-30 March 2000 Page(s):1445 - 1454 vol.3
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- ☐ **20. Way-predicting set-associative cache for high performance and low energy consumption**
Inoue, K.; Ishihara, T.; Murakami, K.;
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1999 Page(s):273 - 275
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Kulkarni, A.; Chander, N.; Pillai, S.; John, L.;
[VLSI, 1998. Proceedings of the 8th Great Lakes Symposium on](#)
19-21 Feb. 1998 Page(s):140 - 145



22. A Way-Halting Cache for Low-Energy High-Performance Systems

Chuanjun Zhang; Vahid, F.; Jun Yang; Walid, W.;

[Computer Architecture Letters, IEEE](#)

Volume 2, Issue 1, Jan.-Feb. 2003 Page(s):5 - 5

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[Computers, IEEE Transactions on](#)

Volume 41, Issue 7, July 1992 Page(s):811 - 825

Digital Object Identifier 10.1109/12.256450

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Mendelson, A.; Thiebaut, D.; Pradhan, D.K.;

[Computers, IEEE Transactions on](#)

Volume 42, Issue 1, Jan. 1993 Page(s):1 - 14

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25. Mitigating soft errors in highly associative cache with CAM-based tag

Hung, L.D.; Goshima, M.; Sakai, S.;

[Computer Design, 2005. Proceedings. 2005 International Conference on](#)

2-5 Oct. 2005 Page(s):342 - 347

Digital Object Identifier 10.1109/ICCD.2005.76

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IEEE CNF	IEEE Conference Proceeding
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